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Kurita et al.

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(54) **FIXING DEVICE AND IMAGE FORMING APPARATUS**

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G03G 15/20 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/2028*** (2013.01); ***G03G 15/2017*** (2013.01); ***G03G 15/2046*** (2013.01); ***G03G 15/2064*** (2013.01); *G03G 2215/2045* (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/2003; G03G 15/2064; G03G 15/2078; G03G 15/2017; G03G 15/2045
USPC 399/67
See application file for complete search history.

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(57) **ABSTRACT**

A fixing device includes a fixing section that includes rotatable members arranged to form a nip area through which a strip-shaped medium passes, and heaters that heat the rotatable members; and a control section. The fixing section applies heat and pressure to a toner image that is formed on the medium and passes through the nip area via the rotatable members heated by the heaters to fix the toner image onto the medium. The control section performs such control that the rotation of the rotatable members is stopped when the temperature of contact portions of the rotatable members that are in contact with the medium is lower than or equal to a first temperature that is lower than a temperature at which a portion of the medium softens.

15 Claims, 12 Drawing Sheets

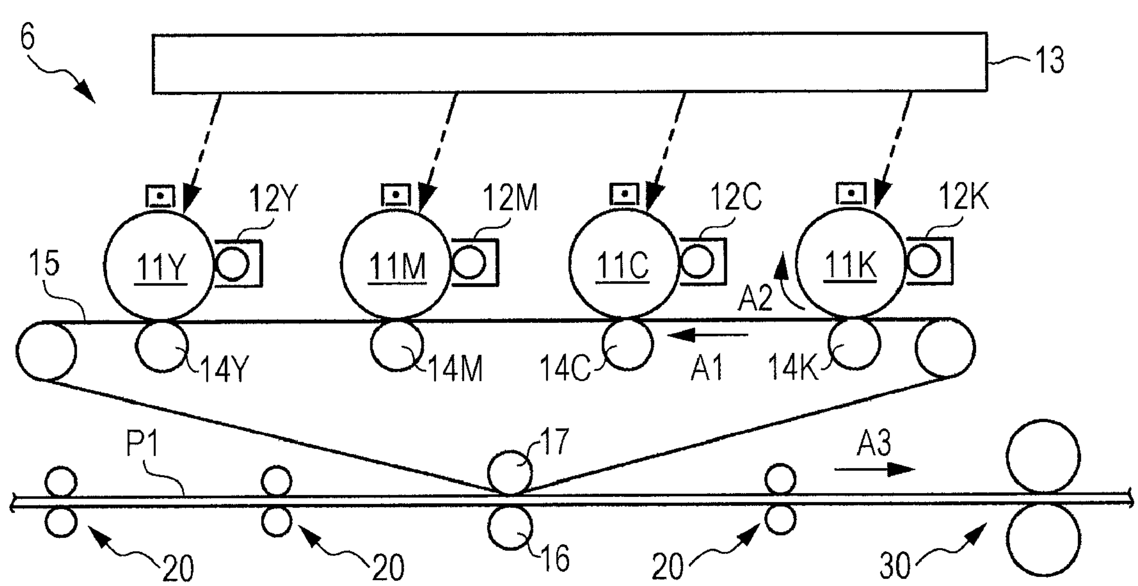


FIG. 1

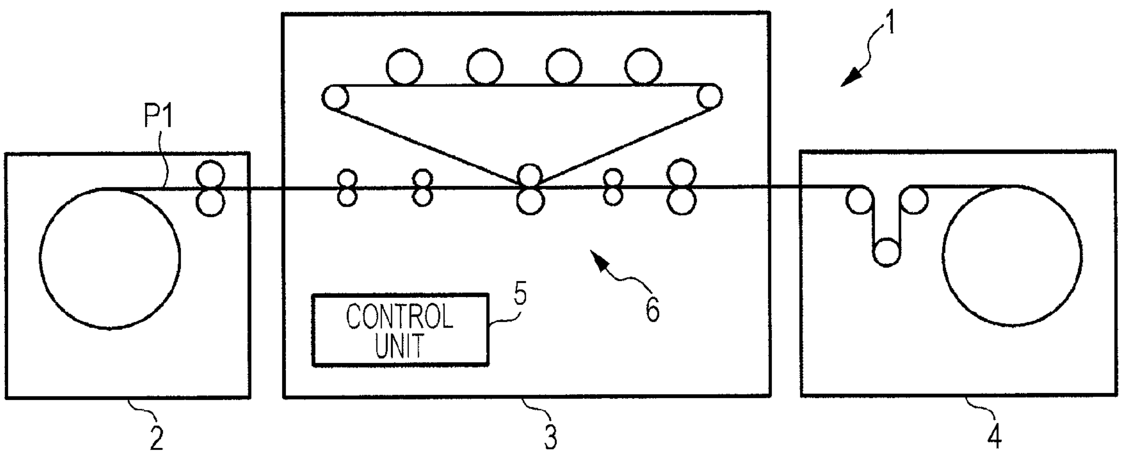

1
P1
CONTROL UNIT
5
6
2
3
4

FIG. 2

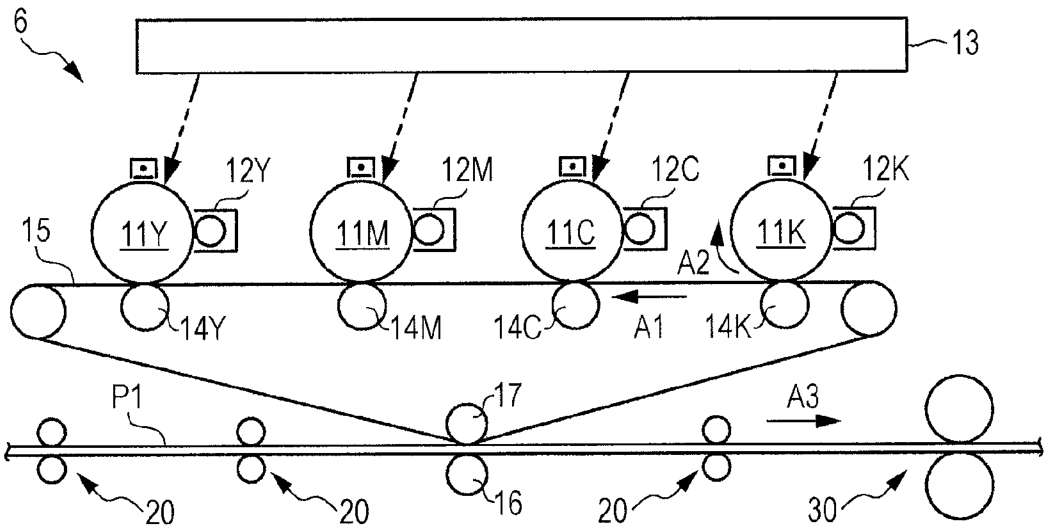

6
13
12Y
12M
12C
12K
11Y
11M
11C
11K
15
A2
14Y
14M
14C
A1
14K
17
P1
A3
20
20
16
20
30

FIG. 3

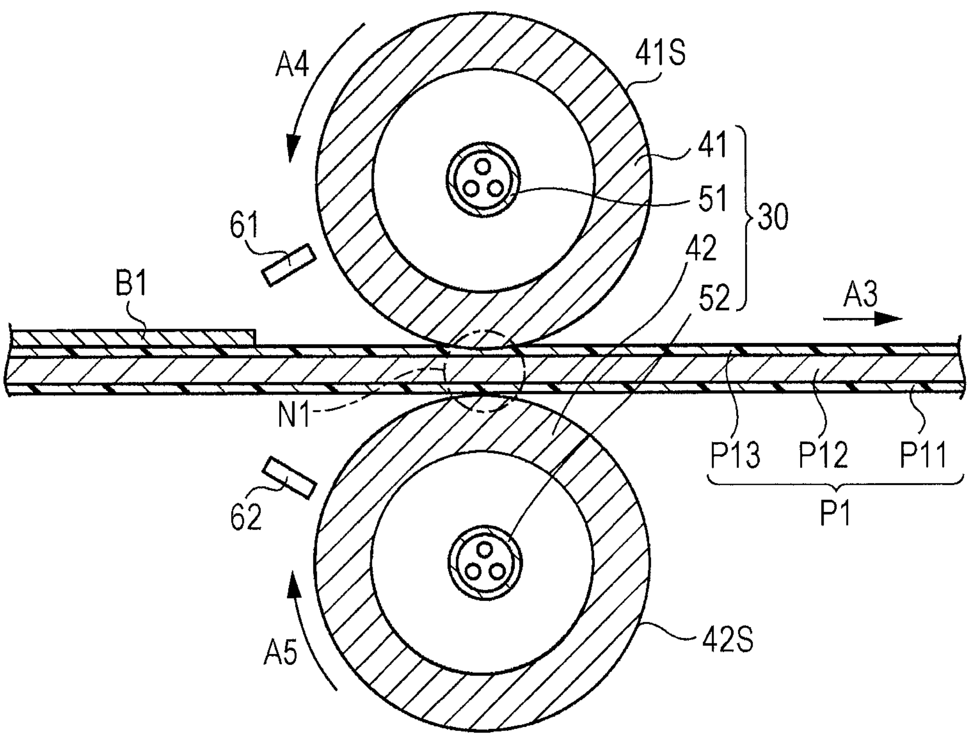

A4
41S
41
51
30
61
42
B1
52
A3
N1
P13
P12
P11
P1
62
42S
A5

FIG. 4

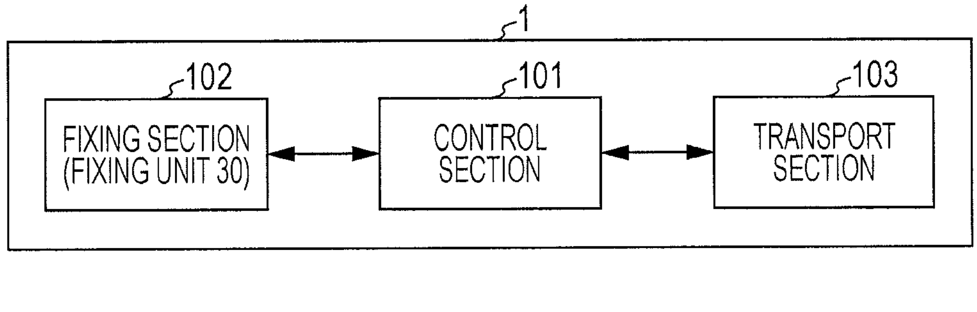

1
102
FIXING SECTION (FIXING UNIT 30)
101
CONTROL SECTION
103
TRANSPORT SECTION

FIG. 5

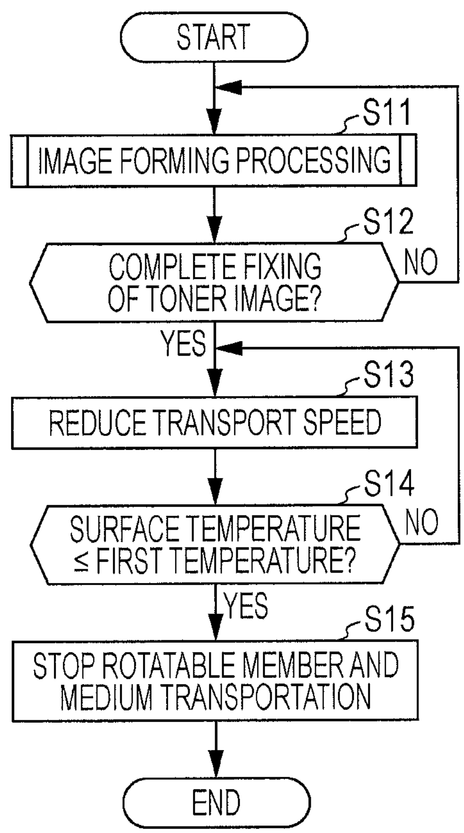

START
S11
IMAGE FORMING PROCESSING
S12
COMPLETE FIXING OF TONER IMAGE?
NO
YES
S13
REDUCE TRANSPORT SPEED
S14
SURFACE TEMPERATURE ≤ FIRST TEMPERATURE?
NO
YES
S15
STOP ROTATABLE MEMBER AND MEDIUM TRANSPORTATION
END

FIG. 6

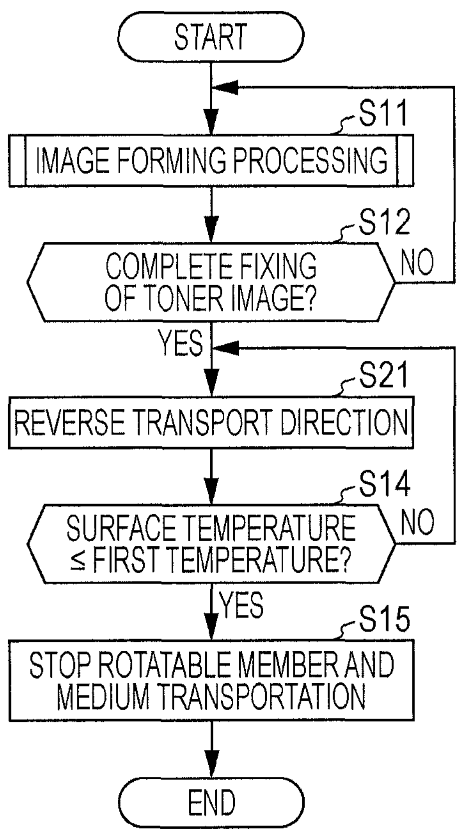

START
S11
IMAGE FORMING PROCESSING
S12
COMPLETE FIXING OF TONER IMAGE?
NO
YES
S21
REVERSE TRANSPORT DIRECTION
S14
SURFACE TEMPERATURE ≤ FIRST TEMPERATURE?
NO
YES
S15
STOP ROTATABLE MEMBER AND MEDIUM TRANSPORTATION
END

FIG. 7

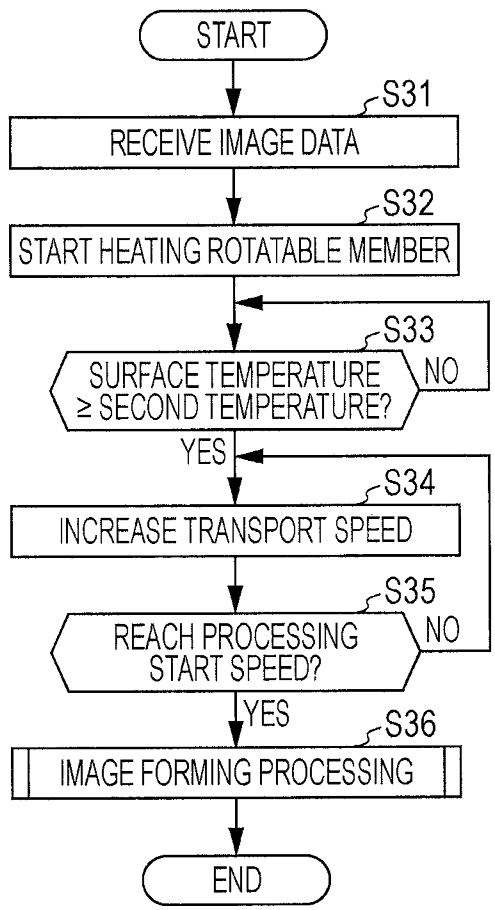

START
S31
RECEIVE IMAGE DATA
S32
START HEATING ROTATABLE MEMBER
S33
SURFACE TEMPERATURE
≥ SECOND TEMPERATURE?
NO
YES
S34
INCREASE TRANSPORT SPEED
S35
REACH PROCESSING
START SPEED?
NO
YES
S36
IMAGE FORMING PROCESSING
END

FIG. 8

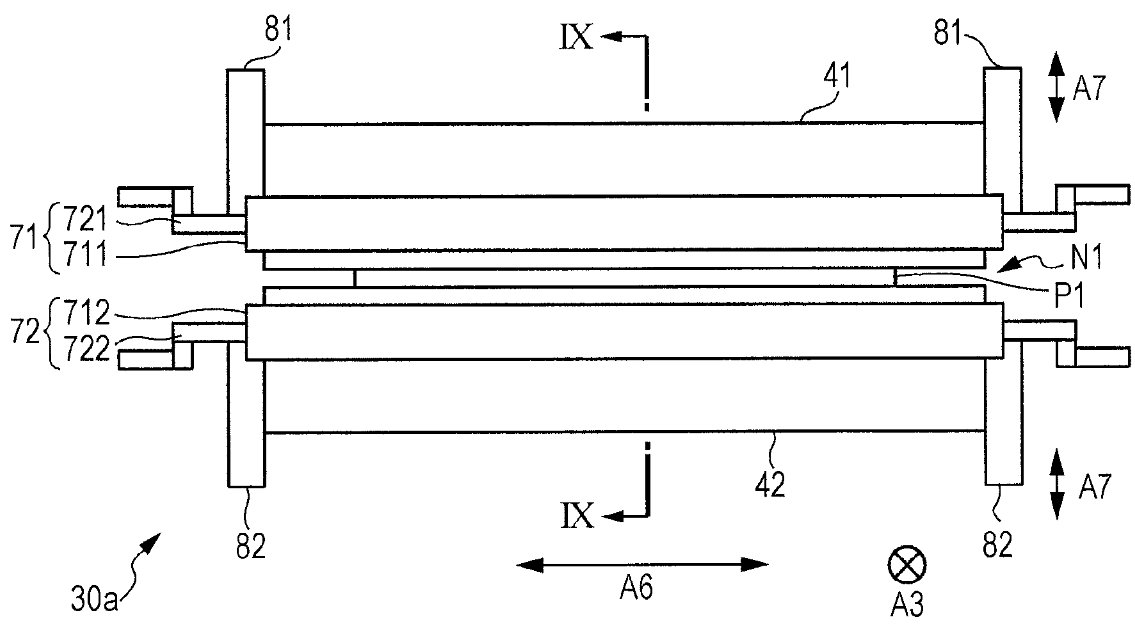


FIG. 9A

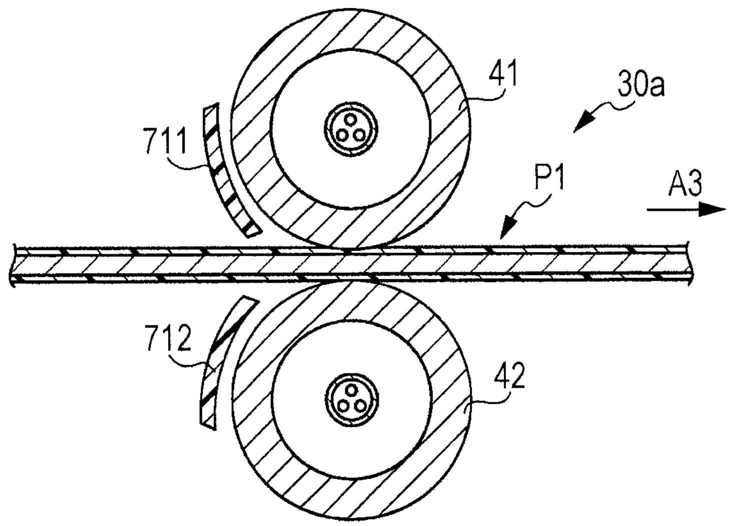


FIG. 9B

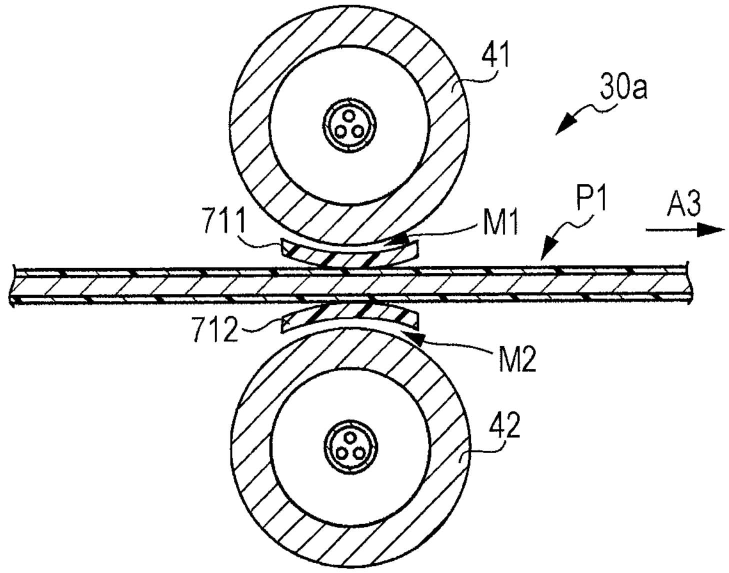


FIG. 10

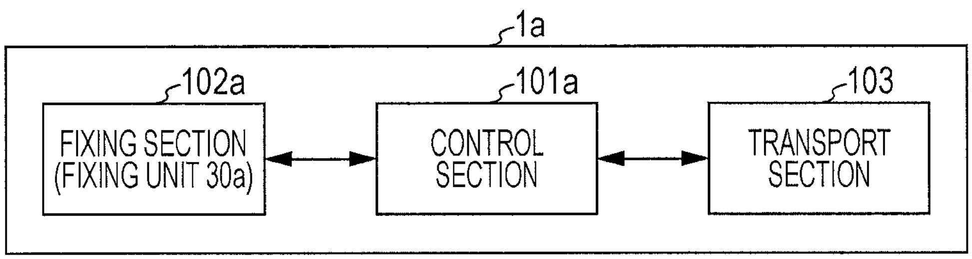

1a
102a
FIXING SECTION
(FIXING UNIT 30a)
101a
CONTROL
SECTION
103
TRANSPORT
SECTION

FIG. 11

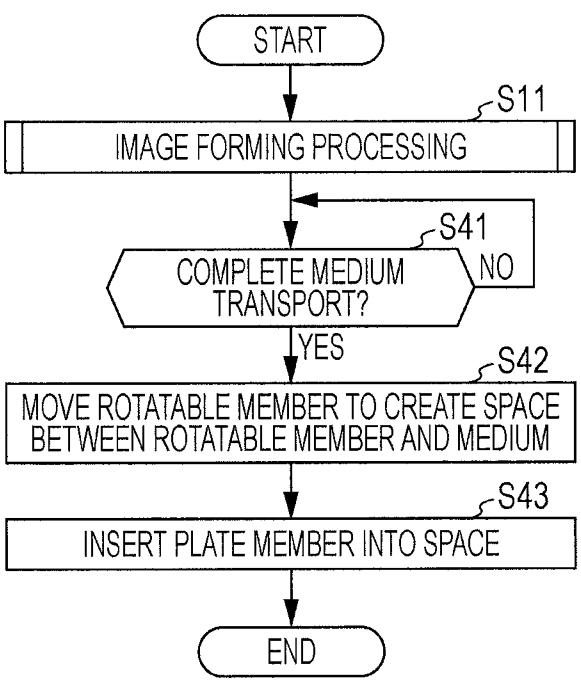

START
S11
IMAGE FORMING PROCESSING
S41
COMPLETE MEDIUM
TRANSPORT?
NO
YES
S42
MOVE ROTATABLE MEMBER TO CREATE SPACE
BETWEEN ROTATABLE MEMBER AND MEDIUM
S43
INSERT PLATE MEMBER INTO SPACE
END

FIG. 12

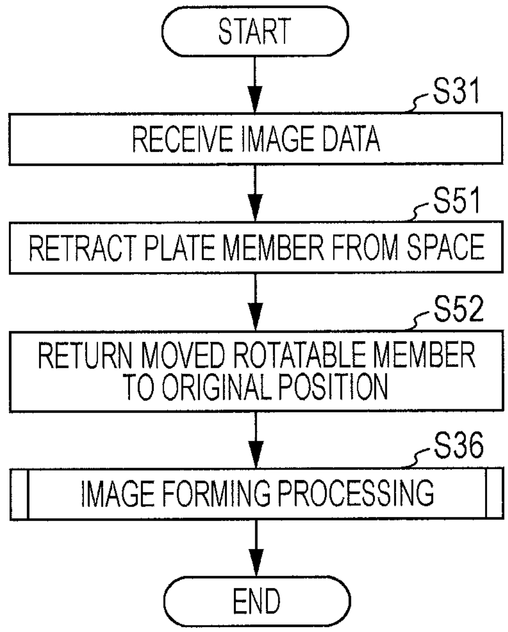

START
S31
RECEIVE IMAGE DATA
S51
RETRACT PLATE MEMBER FROM SPACE
S52
RETURN MOVED ROTATABLE MEMBER TO ORIGINAL POSITION
S36
IMAGE FORMING PROCESSING
END

FIG. 13

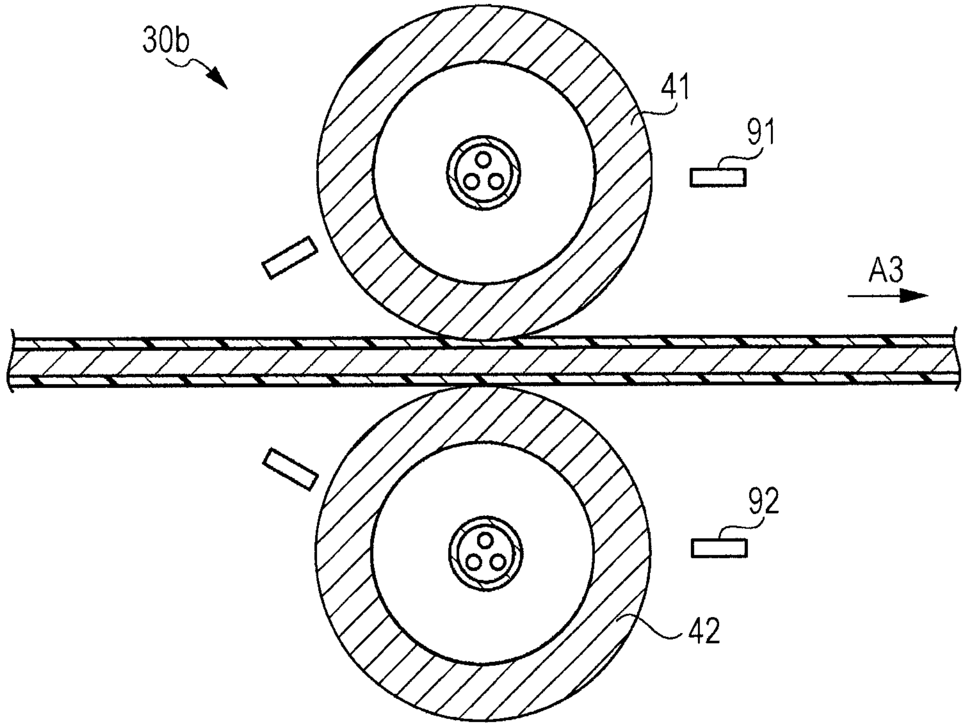

30b
41
91
A3
92
42

FIG. 14A

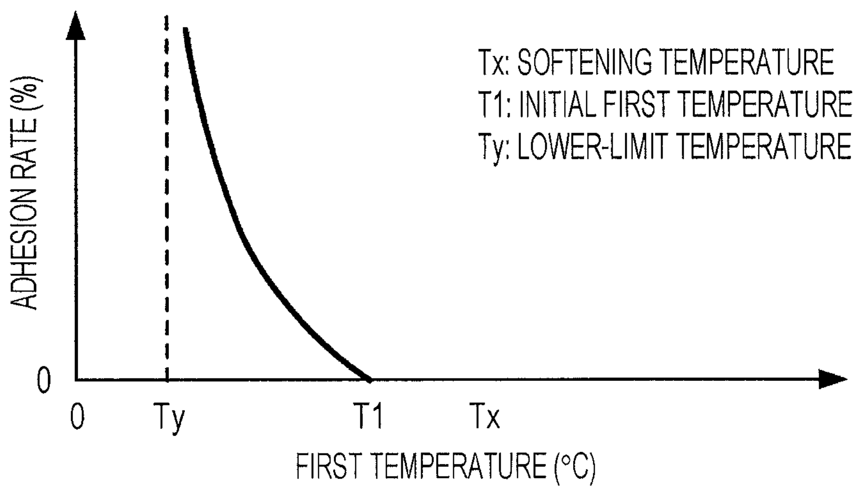


FIG. 14B

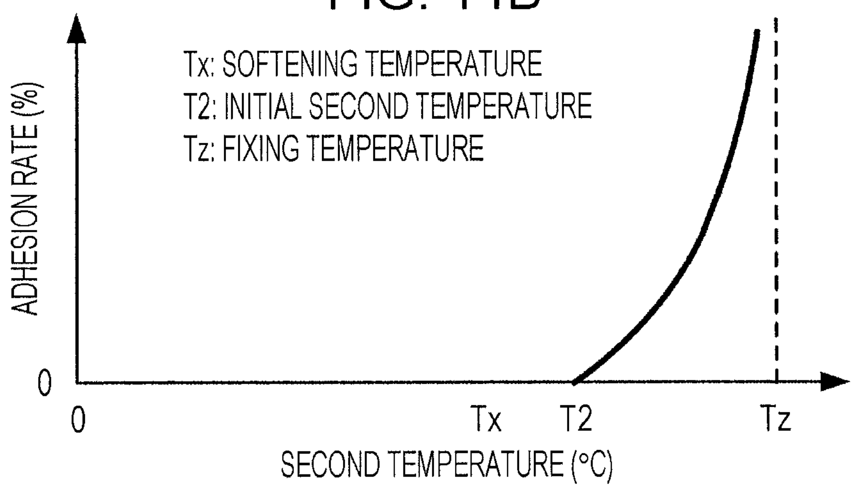


FIG. 15

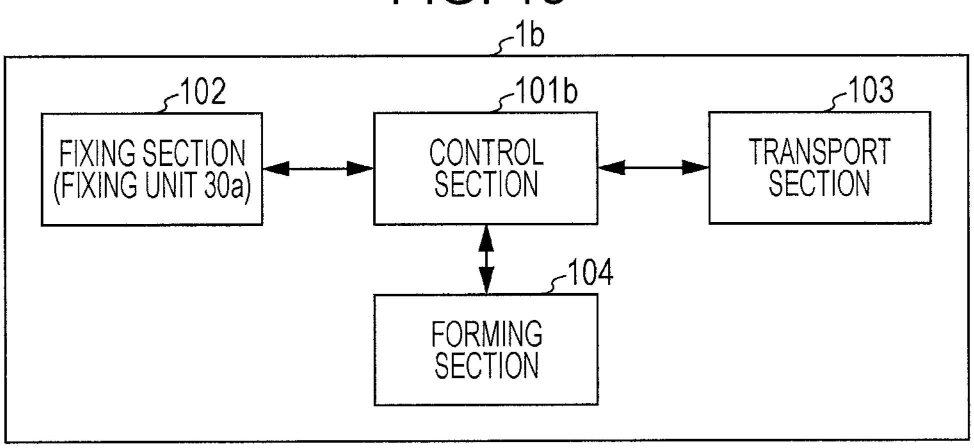


FIG. 16A

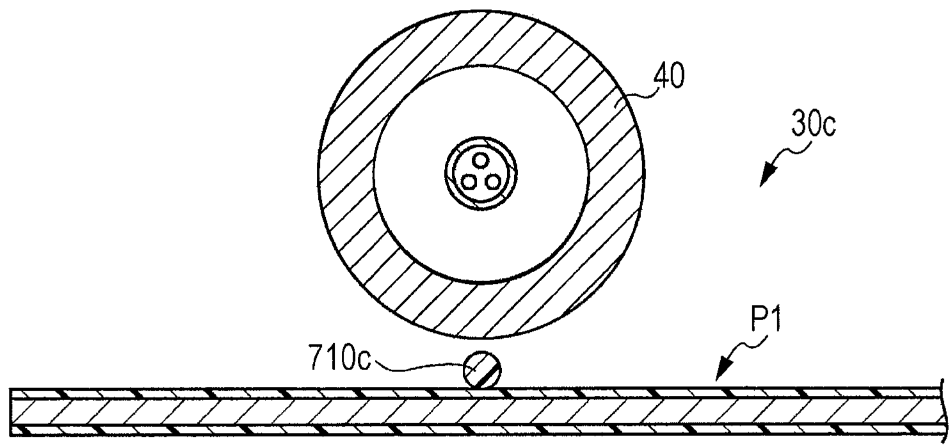


FIG. 16B

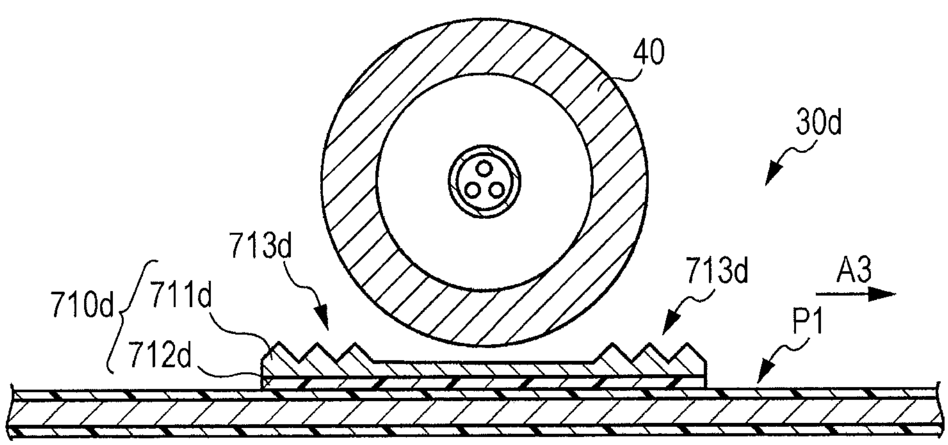


FIG. 17A

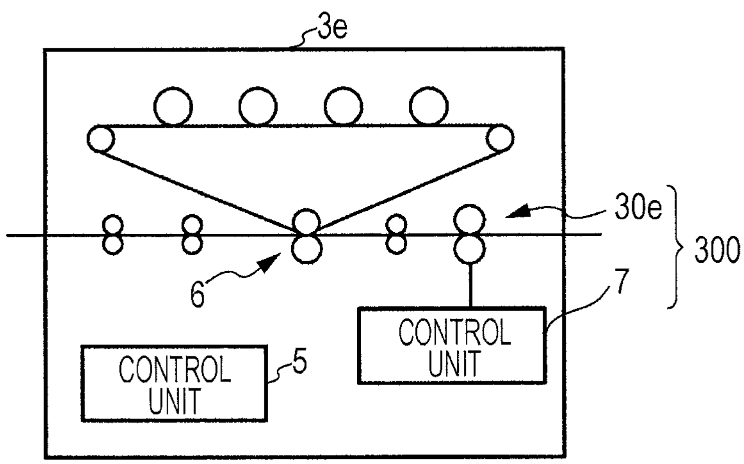
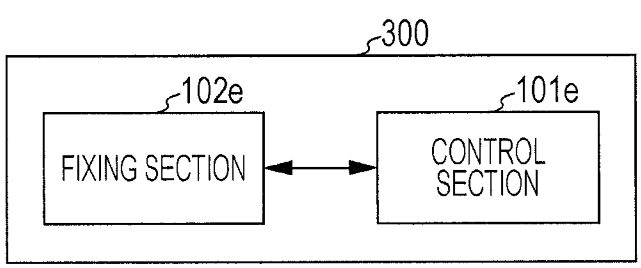


FIG. 17B



FIXING DEVICE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2013-154459 filed Jul. 25, 2013.

BACKGROUND

Technical Field

The present invention relates to a fixing device and an image forming apparatus.

SUMMARY

According to an aspect of the invention, there is provided a fixing device including a fixing section that includes rotatable members arranged to form a nip area through which a strip-shaped medium passes, and heaters that heat the rotatable members; and a control section. The fixing section applies heat and pressure to a toner image that is formed on the medium and passes through the nip area via the rotatable members heated by the heaters to fix the toner image onto the medium. The control section performs such control that the rotation of the rotatable members is stopped when the temperature of contact portions of the rotatable members that are in contact with the medium is lower than or equal to a first temperature that is lower than a temperature at which a portion of the medium softens.

According to the above aspect, a situation where a portion of a medium softens, peels off, and then adheres to a part of the media where a toner image is to be formed, due to the heat of the rotatable member stopped upon the completion of the fixing of a toner image, is less likely to occur than in a case where the control of the fixing device, as in the present invention, is not performed.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** is a diagram showing an exemplary hardware configuration of an image forming system according to the first exemplary embodiment;

FIG. **2** is a diagram showing an exemplary hardware configuration of the image forming apparatus;

FIG. **3** is an enlarged view of a fixing unit;

FIG. **4** is a diagram showing an exemplary functional configuration of the image forming system;

FIG. **5** is a flowchart showing an exemplary operation of the image forming system in adhesion prevention processing;

FIG. **6** is a flowchart showing another exemplary operation of the image forming system in the adhesion prevention processing;

FIG. **7** is a flowchart showing another exemplary operation in adhesion prevention processing according to a second exemplary embodiment;

FIG. **8** is a diagram showing an example of a fixing unit according to a third exemplary embodiment;

FIGS. **9**A and **9**B are diagrams showing a situation where insertion members are inserted into spaces between rotatable members and a medium;

FIG. **10** is a diagram showing an exemplary functional configuration of the image forming system;

FIG. **11** is a flowchart showing an exemplary operation of the image forming system in the adhesion prevention processing;

FIG. **12** is a flowchart showing another exemplary operation of the image forming system in the adhesion prevention processing;

FIG. **13** is a diagram showing an example of a fixing unit according to a modification;

FIGS. **14**A and **14**B are diagrams showing an example of correlation data;

FIG. **15** is a diagram showing an exemplary functional configuration of the image forming system according to the modification;

FIGS. **16**A and **16**B are diagrams showing an example of an insertion member according to the modification; and

FIGS. **17**A and **17**B are diagrams showing exemplary hardware configuration and functional configuration of the fixing device.

DETAILED DESCRIPTION

[1] First Exemplary Embodiment

[1-1] Hardware Configuration

FIG. **1** is a diagram showing an exemplary hardware configuration of an image forming system according to a first exemplary embodiment. FIG. **1** shows an image forming system **1** including a paper feed unit **2**, an image forming apparatus **3**, and a post-processing unit **4**. The paper feed unit **2** supplies a medium P1 to the image forming apparatus **3**, and the image forming apparatus **3** forms an image on the supplied medium P1 using an electrophotographic system. The post-processing unit **4** performs post-processing, such as taking up of the medium P1 with the image formed thereon.

The medium P1, which is also called "continuous paper", is a strip-shaped sheet medium elongated in the direction in which it is transported (hereinbelow, "transport direction"). The medium P1, in the form of a single continuous medium, is transported from a place where it is fed (paper feed unit **2**) to a place where it is stored (post-processing unit **4**) after an image is formed thereon. While the medium P1 is transported, the image forming apparatus **3** continuously forms an image. In this exemplary embodiment, the outer surfaces of the medium P1 are coated with a coating material. This coating may soften and peel off when heated to or above a certain temperature. Details of the softening and peeling will be described below.

The image forming apparatus **3** includes a control unit **5** and an image forming section **6**. The control unit **5** includes a central processing unit (CPU), a read only memory (ROM), a random access memory (RAM), and a real-time clock. The control unit **5** controls the operation of the respective units due to the CPU executing programs stored in the ROM or a storage portion using the RAM as a work area. The real-time clock calculates the current date and time and notifies the CPU thereof. The control unit **5** includes a hard disk etc. that stores data and programs used by the CPU for control. The control unit **5** is connected to an external unit via a network (not shown). When receiving image data from the external unit, the control unit **5** controls the paper feed unit **2**, the image forming apparatus **3**, and the post-processing unit **4** to perform image forming processing, in which an image is formed on a medium P1 according to the image data. The image forming system **1** is a computer that processes image information using the CPU. The image forming section **6** will be described below with reference to FIG. **2**.

FIG. **2** is a diagram showing an exemplary hardware configuration of the image forming section **6**. The image forming section **6** forms a color image by fixing four colors of toner, i.e., yellow (Y), magenta (M), cyan (C), and black (K), on a recording medium, such as a sheet. The image forming section **6** accommodates a photoconductor drum **11**, a charging unit, a developing unit **12**, and a first-transfer roller **14** for each color. These units are arranged along an intermediate transfer belt **15**, in the order of Y, M, C, and K in an arrow A1 direction. In FIG. **2**, the reference numeral of each unit is accompanied by an alphabet (Y, M, C, or K) at the end thereof, showing that the unit is used to form an image corresponding to the color denoted by the alphabet. The alphabets at the end of the reference numerals will be omitted where distinction is not needed.

Each photoconductor drum **11** is rotated in an arrow A2 direction and carries an electrostatic latent image and toner image formed on the surface thereof. The surface of the photoconductor drum **11** is charged to a predetermined electric potential by the charging unit. An exposure unit **13** irradiates (exposes) the surface of the charged photosensitive layer with (to) light (exposure light) that is controlled in intensity and irradiation position in accordance with the above-described image data to form an electrostatic latent image expressing an image indicated by the image data. The developing unit **12** supplies developer containing charged toner to the photoconductor drum **11** to develop the electrostatic latent image into a toner image. The first-transfer roller **14** is provided so as to face the photoconductor drum **11** with the intermediate transfer belt **15** therebetween. A voltage applied to the first-transfer roller **14** and the photoconductor drum **11** causes an electric potential difference between the photoconductor drum **11** and the intermediate transfer belt **15**, causing the charged toner to move to the intermediate transfer belt **15** (first-transfer).

The intermediate transfer belt **15** is an endless belt that carries the toner image first-transferred thereto. The intermediate transfer belt **15** is supported by multiple support rollers in such a manner that it is rotated in the arrow A1 direction by a driving force applied thereto. K, C, M, and Y toner images are sequentially first-transferred from the photoconductor drums **11** to the intermediate transfer belt **15**. The second-transfer roller **16** and the backup roller **17** are provided so as to face each other with the intermediate transfer belt **15** therebetween, forming a nip.

Transport rollers **20** transport the medium P1 in a transport direction A3, in cooperation with the paper feed unit **2** and the post-processing unit **4** shown in FIG. **1**. The paper feed unit **2**, the transport rollers **20**, and the post-processing unit **4** are an example of a transport section that transports the medium P1. The transport rollers **20** transport the medium P1 to the nip. The medium P1 comes into contact with the intermediate transfer belt **15** at the nip. A voltage is applied to the second-transfer roller **16** so as to generate an electric potential difference between the second-transfer roller **16** and the backup roller **17**, causing the toner image to be second-transferred from the intermediate transfer belt **15** to the medium P1. In this manner, the toner image is formed on the medium P1. The photoconductor drum **11**, the exposure unit **13**, the developing unit **12**, the first-transfer roller **14**, the intermediate transfer belt **15**, the second-transfer roller **16**, and the backup roller **17** form a toner image on a medium transported by the transport device and are an example of a "forming section" of the present invention.

The fixing unit **30** is an example of a fixing section that fixes a toner image formed on a medium P1 to the medium P1.

FIG. **3** is an enlarged view of the fixing unit **30** shown in FIG. **2**. The fixing unit **30** includes rotatable members **41** and **42** (hereinbelow, collectively referred to as "rotatable members **40**" where distinction is not needed) and heaters **51** and **52** (hereinbelow, collectively referred to as "heaters **50**" where distinction is not needed). The rotatable members **41** and **42** are cylindrical members (rollers) that are rotated about cylindrical shafts. The rotatable members **41** and **42** are supported so as to nip the medium P1 therebetween. The rotatable member **41** is rotated in a rotation direction A4 indicated by the corresponding arrow, and the rotatable member **42** is rotated in a rotation direction A5 indicated by the corresponding arrow, thereby transporting the medium P1 in the transport direction A3. The rotatable members **41** and **42** form a nip area N1, through which the medium P1 passes during transportation.

The rotatable members **41** and **42** are urged against each other by springs or the like (not shown) to apply pressure to the medium P1 and a toner image (toner image B1 in an example of FIG. **3**) formed on the medium P1, which pass through the nip area N1. The rotatable members **41** and **42** have the heaters **51** and **52** therein. The heaters **51** and **52** heat the rotatable members **41** and **42**, respectively, with, for example, halogen lamps that generate heat when powered.

The fixing unit **30** applies heat and pressure to the toner image B1, which is formed on, for example, the medium P1 and passes through the nip area N1, via the rotatable members **40** heated with the heaters **50** to fix the toner image B1 to the medium P1. At this time, the rotatable members **40** are heated by the heaters **50** such that the temperature of the surfaces thereof (hereinbelow, "surface temperature") is maintained at a temperature required to fix the toner image B1 (hereinbelow, "fixing temperature"). Because the heating with the heaters **50** stops upon the completion of the fixing, the surface temperature of the rotatable members **40** gradually decreases to a temperature corresponding to the environmental temperature.

The medium P1 has softenable layers P11 and P13 (hereinbelow, collectively referred to as "softenable layers P10" where distinction is not needed) on the outer surfaces, and a sheet member P12 interposed therebetween. The sheet member P12 is a strip-shaped sheet member made of paper, film, polyethylene terephthalate (PET), or the like. The softenable layers P10 are made of, for example, resin and coat the sheet member P12. The softenable layers P10 may soften at a certain temperature (hereinbelow, "softening temperature") lower than or equal to the fixing temperature.

As mentioned above, because the medium P1 is continuous from the paper feed unit **2** to the post-processing unit **4**, a portion thereof is still located in the nip area N1 after the fixing. In this exemplary embodiment, the fixing unit **30** does not have a separating device that separates the rotatable members **40** and the medium P1 (or, that brings the rotatable members **40** and the medium P1 out of contact with each other). Hence, the rotatable members **40** are kept in contact with the medium P1 even when the medium P1 is not transported because no image forming operation is performed.

Also shown in FIG. **3** are temperature sensors **61** and **62** (hereinbelow, collectively referred to as "temperature sensors **60**" where distinction is not needed) that are used to measure the temperatures of surfaces **41**S and **42**S of the rotatable members **41** and **42**, respectively. The temperature sensors **60** are, for example, radiation thermometers, which measure the temperature of a surface of an object without touching it, and supply temperature data indicating the measured temperatures of the surfaces (**41**S and **42**S) to the control unit **5** shown in FIG. **1**. The temperature sensors **60** supply the temperature data to the control unit **5** every predetermined time (for example, every 0.1 second). The temperature sensors **60** are provided on the upstream side of the nip area N1 in the rotation direction (A4 or A5) and measure the temperatures of the surfaces of the rotatable members immediately before arriving at the nip area N1.

[1-2] Functional Configuration

As has been described above, the medium P1 has the softenable layers P10 on the outer surfaces thereof. Let us assume that the softening temperature of the medium P1 is X° C. (for example, 100° C.), and the surface temperature of the rotatable members **40** when fixing toner images, i.e., the fixing temperature, is Y° C. (for example, 180° C.). In this exemplary embodiment, X° C. is lower than Y° C. Hence, a portion (more specifically, the softenable layers P10) of the medium P1 may be softened by the heat remaining in the rotatable members **40** stopped upon the completion of the fixing of a toner image and adhere to the surfaces of the rotatable members **40**. The image forming system **1** performs adhesion prevention processing to prevent such a situation using the above-described hardware configuration. The control unit **5** controls the respective units through the execution of the programs to achieve the following functions.

FIG. **4** is a diagram showing an exemplary functional configuration of the image forming system **1**. The image forming system **1** includes a control section **101**, a fixing section **102**, and a transport section **103**. The transport section **103** is a function achieved by the paper feed unit **2**, the transport rollers **20**, and the post-processing unit **4** and transports a strip-shaped medium. The fixing section **102** is a function achieved by the fixing unit **30** and fixes a toner image formed on the strip-shaped medium and passing through the nip area N1 onto the medium.

The control section **101** is an example of a section that controls the fixing section **102** so as to perform an operation (hereinbelow, "suppressing operation") for preventing a portion of the medium P1 from softening, peeling off, and adhering to the rotatable members **40** due to the heat of the rotatable members **40** stopped upon the completion of the fixing.

In this exemplary embodiment, the control section **101** stops the rotation of the rotatable members **40** when the temperature of portions (hereinbelow, "contact portions") of the rotatable members **40** that are in contact with the medium P1 is lower than or equal to a certain temperature (hereinbelow, a "first temperature"). The contact portions are portions of the surfaces of the rotatable members **40** that are in contact with the medium P1 in the nip area N1. Because the control section **101** stops the rotation of the rotatable members **40** in this manner, the medium P1 is less likely to soften and a portion of the softened medium P1 is less likely to adhere to the rotatable members **40** than in a case where the rotation of the rotatable members **40** is stopped when the temperature of the contact portions is higher than the first temperature. The operation of stopping the rotation of the rotatable members **40** by the control section **101** in this way is the above-described suppressing operation. More specifically, the control section **101** stops the rotation of the rotatable members **40** by using a temperature below the above-mentioned softening temperature (temperature at which the softenable layers P10 of the medium P1 soften) as the first temperature. The control section **101** also controls the transport section **103**, in addition to the fixing section **102**. For example, the control section **101** reduces the speed at which the medium is transported (hereinbelow, "transport speed") after the toner image is fixed onto the medium.

The control section **101** is a function achieved by the control unit **5** and the temperature sensors **60**. The control unit **5** controls the transport section **103** to transport the medium at varying transport speeds. The control unit **5** calculates, from, for example, the transport speed and the time of the last emission of the exposure light from the exposure unit **13** according to image data instructing the formation of an image, the time when the fixing of the toner image according to the image data is completed. It is also possible that a sensor for detecting an image is provided on the downstream side of the nip area N1 in the transport direction to enable the control unit **5** to obtain the time of the completion of the fixing on the basis of the data showing the detection results of the sensor.

When the time of the completion of the fixing has passed, the control unit **5** determines that the fixing of the toner image on the medium P1 has been completed and then reduces the transport speed by controlling the transport section **103**. When, for example, the transport speed may be varied across ten levels, the control unit **5** reduces the transport speed by one level every 10 seconds. The control unit **5** stores Z° C. (for example, 80° C.), which is lower than the softening temperature X° C. (for example, 100° C.) (X>Z), as the first temperature. It is desirable that Z° C. be in such a temperature range in which the surface temperature of the rotatable members **40** falls after heating by the heaters **50** is stopped.

When the time of the completion of the fixing has passed, the control unit **5** determines if the temperature indicated by the supplied temperature data is lower than or equal to the first temperature every time when the temperature data is supplied by the temperature sensors **60**. When it is determined that the temperature is lower than or equal to the first temperature, the control unit **5** stops the rotation of the rotatable members **40** by controlling the fixing section **102**. At the same time, the control unit **5** stops the transportation of the medium P1 by controlling the transport section **103**.

[1-3] Operation

The image forming system **1** performs the above-described adhesion prevention processing (processing for preventing a portion of the softened medium from adhering to the rotatable members), using the above-described configuration.

FIG. **5** is a flowchart showing an exemplary operation of the image forming system **1** in the adhesion prevention processing. First, the image forming system **1** performs image forming processing for forming an image that is indicated by image data transmitted from an external unit (step S**11**). Next, the image forming system **1** determines if the fixing of a toner image expressing the required image has been completed (step S**12**). When it is determined that the fixing of the toner image is not yet completed (NO), the image forming system **1** performs the operation of step S**11**. When it is determined that the fixing of the toner image has been completed (YES) in step S**12**, the image forming system **1** reduces the transport speed (step S**13**). Steps S**12** and S**13** are the operations performed by the control section **101** and the transport section **103**.

Next, the image forming system **1** determines if the surface temperature of the rotatable members **40** has dropped to or below the first temperature (step S**14**). When it is determined that the surface temperature has not yet dropped to or below the first temperature (NO), the image forming system **1** returns to step S**13** and performs the operation. Note that the image forming system **1** does not necessarily have to reduce the transport speed every time when it returns to step **S13**, and, in the case of reducing the transport speed by one level every 10 seconds as described above, the transport speed is reduced when 10 seconds have elapsed since the previous reduction in the transport speed. When it is determined that the surface temperature has dropped to or below the first temperature in step **S14** (YES), the image forming system **1** stops the rotation of the rotatable members **40** and the transportation of the medium (step **S15**). Steps **S14** and **S15** are the operations performed by the control section **101**, the fixing section **102**, and the transport section **103**.

[1-4] Other Examples

Although the control section **101** reduces the transport speed in step **S13** in the example above, the control performed by the control section **101** is not limited thereto. For example, the control section **101** repeatedly reverses the transport direction of the medium P1 by controlling the fixing section **102** and the transport section **103**. More specifically, the control section **101** reverses the transport direction every time when a predetermined time (e.g., 10 seconds) has elapsed. Alternatively, the control section **101** may reverse the transport direction every time when the medium P1 has been transported by a predetermined length.

FIG. **6** is a flowchart showing another exemplary operation of the image forming system **1** in the adhesion prevention processing. In this example, the image forming system **1** reverses the transport direction of the medium P1 (step **S21**) when it is determined that the fixing of the toner image has been completed (YES) in step **S12**.

The control section **101** may perform both reduction in transport speed and repeated reversing of the transport direction. In this case, the control section **101** may perform the reduction in transport speed and the reversing of transport direction either at the same or different intervals. Furthermore, the control section **101** may vary the intervals or may terminate the reduction in transport speed and the reversing of transport direction when a predetermined number of times has been reached.

[1-5] Advantages of First Exemplary Embodiment

In this exemplary embodiment, when the surface temperature of the contact portions of the rotatable members **40** is lower than or equal to the first temperature, which is below the softening temperature, the rotation of the rotatable members **40** is stopped. The surfaces of the medium P1 that are in contact with the surfaces of the rotatable members **40** at the first temperature will not soften. Hence, according to this exemplary embodiment, the medium does not soften after the transportation of the medium has been stopped. Furthermore, in this exemplary embodiment, the fixing section **102** does not have a separating device. Because the space for providing a device that separates the rotatable members **40** and the medium P1 is unnecessary, the apparatus is smaller than that with the separating device.

When a portion of the softened medium P1 adheres to the rotatable members **40**, the portion may be transferred from the rotatable members **40** to another part of the medium P1. That is, a portion of the softened medium P1 adheres to the medium P1 itself via the rotatable members **40**. In this exemplary embodiment, the control section **101** performs the above-described suppressing operation (operation for preventing a portion of the medium P1 from softening, peeling off, and adhering to the rotatable members **40**) by controlling the fixing section **102**. Accordingly, adhesion of a portion of the softened medium P1 to the medium P1 via the rotatable members **40** is less likely to occur than in a case where the suppressing operation is not performed. In this exemplary embodiment, the adhesion of a portion of the medium softened by the heat of the rotatable members heated in the fixing operation to the medium itself is less likely to occur than in a case where the suppressing operation is not performed, i.e., a case where the control of the fixing section as described above is not performed.

Furthermore, in this exemplary embodiment, after it is determined that the fixing of the toner image on the medium P1 has been completed, an operation such as reducing the transport speed or reversing the transport direction is performed. By doing so, the amount of the medium P1 transported until the rotation of the rotatable members **40** is stopped, i.e., until the transportation of the medium P1 is stopped, is reduced compared with a case where the transportation of the medium P1 is continued without changing the transport speed or transport direction. The medium P1 that has been transported from the completion of the fixing to the stopping of the rotation of the rotatable members **40** is not used for forming an image. In other words, according to this exemplary embodiment, the amount of medium that is not used for forming an image is smaller than that in a case where the above-described control of the transport section and a pressure section is not performed.

[2] Second Exemplary Embodiment

A second exemplary embodiment of the present invention will be described below, focusing on the difference from the first exemplary embodiment. In the first exemplary embodiment, the control performed when stopping the rotation of the rotatable members **40** has been described. In the second exemplary embodiment, the control performed when starting the rotation of the rotatable members **40** will be described.

[2-1] Functional Configuration

In this exemplary embodiment, the control section **101** starts the rotation of the rotatable members **40** when the temperature (i.e., surface temperature) of the contact portions (portions in contact with the medium P1) of the rotatable members **40** is higher than or equal to a second temperature. If a portion of the softened medium P1 adheres to the contact portions, the portion may peel off from the medium P1 and stay on the contact portions when the rotatable members **40** are rotated. If the rotation is started when the temperature of the contact portions is higher than or equal to the second temperature, the portion softens again due to the heat conducting from the contact portions and is easily detached from the contact portions compared with a case where the temperature of the contact portions is lower than the second temperature. The operation of starting the rotation by the control section **101** in this way is the above-described suppressing operation (operation for preventing a portion of the medium P1 from softening, peeling off, and adhering to the rotatable members **40**). More specifically, the control section **101** starts the rotation of the rotatable members **40** by using a temperature that is higher than or equal to the softening temperature (temperature at which the softenable layers P10 of the medium P1 soften) as the second temperature.

When, for example, image data is transmitted from an external unit, the control section **101** stores W° C. (for example, 140° C.), which is higher than or equal to the above-described softening temperature X° C. (for example, 100° C.) (W>X), as the second temperature. Note that it is desirable that W° C. be less than the surface temperature of the rotatable members **40** when fixing a toner image, i.e., fixing temperature Y° C. (for example, 180° C.). For example, when image data is transmitted from an external unit, the control section **101** determines if the temperature indicated by the supplied temperature data is higher than or equal to the second temperature each time when the temperature data is supplied from temperature sensors **60**. When it is determined that the temperature is higher than or equal to the second temperature, the control section **101** starts the rotation of the rotatable members **40** by controlling the fixing section **102**.

Furthermore, after the temperature of the contact portions of the rotatable members **40** has reached or exceeded the second temperature, the control section **101** gradually increases the transport speed of the medium P1 by controlling the transport section **103**. For example, the control section **101** preliminarily determines the medium transport speed at the time when image forming processing is started (this transport speed is referred to as "processing start speed") and, when the transport speed may be varied across 10 levels to the processing start speed, increases the transport speed by one level at predetermined time intervals (e.g., every second).

[2-2] Operation

FIG. **7** is a flowchart showing another exemplary operation of the image forming system **1** according to the second exemplary embodiment in the adhesion prevention processing. First, the image forming system **1** receives image data transmitted from an external unit (step S**31**). Next, the image forming system **1** starts the heating of the rotatable members **40** (step S**32**). Then, the image forming system **1** determines if the surface temperature of the contact portions of the rotatable members **40** has reached or exceeded the second temperature (step S**33**). When it is determined that the surface temperature has not yet reached or exceeded the second temperature (NO), the image forming system **1** repeatedly performs the operation of step S**33**. When it is determined that the surface temperature has reached or exceeded the second temperature (YES), the image forming system **1** increases the transport speed (step S**34**).

Then, the image forming system **1** determines if the transport speed has reached the processing start speed (step S**35**). When it is determined that the transport speed has not yet reached the processing start speed (NO), the image forming system **1** returns to step S**34** and performs the operation. When it is determined that the transport speed has reached the processing start speed (YES), the image forming system **1** performs the image forming processing (step S**36**).

[2-3] Other Examples

In the second exemplary embodiment too, the control section **101** may repeatedly reverses the medium transport direction. More specifically, the control section **101** reverses the transport direction at predetermined time intervals (e.g., every one second), after the temperature of the contact portions of the rotatable members **40** has reached or exceeded the second temperature. Furthermore, as described above, the control section **101** may gradually increase the transport speed while repeatedly reversing the transport direction.

[2-4] Advantage of Second Exemplary Embodiment

In the second exemplary embodiment, when the temperature of the contact portions of the rotatable members **40** is higher than or equal to the second temperature, which is higher than or equal to the softening temperature, the rotation of the rotatable members **40** is started. With this configuration, when a portion (more specifically, the softenable layers P10) of the softened medium P1 adheres to the rotatable members **40**, the adherent softens again before the rotation of the rotatable members **40** is started. At this time, the softened adherent may adhere to the medium P1, not to the rotatable members **40**, as a result of the start of the rotation of the rotatable members **40**. If the second temperature is lower than the softening temperature, the adherent does not soften before the rotation of the rotatable members **40** is started and, hence, remains on the rotatable members **40** even after the rotation is started. According to this exemplary embodiment, a portion of the medium adhered to the rotatable member (i.e., the above-mentioned adherent) is easily detached from the rotatable member compared with a case where a temperature lower than the softening temperature is used as the second temperature.

The adherent softened as described above is more easily detached if it is brought into contact with the medium in a more softened state. In this exemplary embodiment, the transport speed is gradually increased until the transport speed reaches the processing start speed (medium transport speed at the time when the image forming processing is started). Hence, the duration of time for which the softened adherent is in contact with the medium is increased, enabling a large amount of adherent to be detached compared with a case where the transport speed is more quickly increased.

The more the adherent is brought into contact with the medium, the more the adherent is detached. However, this increases the amount of medium on which an image is not formed. In this exemplary embodiment, the transport direction is reversed until the transport speed reaches the processing start speed. By doing so, the amount of medium on which an image is not formed decreases compared with a case where the transport direction is not changed.

[3] Third Exemplary Embodiment

A third exemplary embodiment of the present invention will be described below, focusing on the difference from the first and second exemplary embodiments. In the first and second exemplary embodiments, the fixing section does not have a separating device (a device that separates the rotatable members **40** and the medium P1). However, in the third exemplary embodiment, the fixing section includes separating devices and members (hereinbelow, "insertion members") that may be inserted into the spaces between the rotatable members **40** and the medium P1 created by separating them.

[3-1] Hardware Configuration

FIG. **8** is a diagram showing an example of the fixing unit according to the third exemplary embodiment. In this example, a fixing unit **30***a* oriented in the transport direction A3 for the medium P1 is shown. In FIG. **8**, a direction along rotation shafts of the rotatable members **40** is referred to as a width direction A6 (direction across the width of the medium P1), and a direction along the perpendicular of the medium P1 in the nip area N1 is referred to as a top-bottom direction A7. The fixing unit **30***a* includes insertion units **71** and **72** (hereinbelow, collectively referred to as "insertion units **70**" where distinction is not needed) and separating units **81** and **82** (hereinbelow, collectively referred to as "separating units **80**" where distinction is not needed).

The insertion units **71** and **72** have insertion members **711** and **712** (hereinbelow, collectively referred to as "insertion members **710**" where distinction is not needed) and rotation portions **721** and **722** (hereinbelow, collectively referred to as "rotation portions **720**" where distinction is not needed). The insertion members **710** are larger than the rotatable members **40** in the width direction and are made of, for example, poly phenylene sulfide resin (PPS) containing glass. Alternatively, the insertion members **710** may be made of a material such as liquid crystal polymer (LCP), sheet metal, or a compacted glass wool and polyimide. It is desirable that the insertion members **710** be made of a material having lower thermal conductivity, higher thermal resistance, or larger specific heat. The thermal conductivity is measured by, for example, a steady heat flow method or a transient heat flow method. The thermal resistance is a value obtained by dividing the thickness of the member by the thermal conductivity. The thickness of the member in this case is a thickness in the direction from the heaters **50** toward the medium P1. In this exemplary embodiment, the insertion members **710** have lower thermal conductivity, higher thermal resistance, or larger specific heat than the rotatable members **40**.

The insertion members **710** are provided on the upstream side of the rotatable members **40** in the transport direction A3, and the both ends thereof in the width direction A6 are connected to the rotation portions **720**. The rotation portions **720** are supported so as to be rotatable about the rotation shafts of the rotatable members **40**. The rotation portions **720** are controlled by the control unit **5** so as to be rotated or stopped. The separating units **80** are provided at both ends of the rotatable members **40** in the width direction A6 and move the rotatable members **40** in the top-bottom direction A7. The separating units **80** are an example of a separating device and separate the rotatable members **40** and the medium P1 by moving the rotatable members **40** in a direction away from the medium P1.

FIGS. **9**A and **9**B are diagrams showing a situation where the insertion members **710** are inserted into spaces between the rotatable members **40** and the medium P1. FIGS. **9**A and **9**B show the end faces of the fixing unit **30***a* and medium P1, as viewed in a direction indicated by allows IX-IX in FIG. **8**. The insertion members **710** are plate members that are curved along the surfaces of the rotatable members **40**. FIG. **9**A shows a state in which the insertion members **710** are disposed with the curved surfaces facing the surfaces of the rotatable members **40**. FIG. **9**B shows a state in which the insertion member **711** is inserted into a space M1 and the insertion member **712** is inserted into a space M2, which spaces are produced by separating the rotatable members **40** and the medium P1 using the separating units **80** shown in FIG. **8**. In this manner, the insertion members **710** are inserted into the spaces between the rotatable members **40** and the medium P1. Furthermore, by the respective driving units performing operations opposite from those described above, the insertion members **710** return to the state shown in FIG. **9**A from the state shown in FIG. **9**B. In this case, the insertion members **710** are retracted from the spaces between the rotatable members **40** and the medium P1. The fixing unit **30***a* has the insertion members **710** that may be inserted into or retracted from the spaces between the rotatable members **40** and the medium P1, produced by the separating units **80**.

[3-2] Functional Configuration

FIG. **10** is a diagram showing an exemplary functional configuration of the image forming system according to this exemplary embodiment. This example shows an image forming system **1***a* that includes a control section **101***a*, a fixing section **102***a*, and the transport section **103**. The fixing section **102***a* is a function achieved by the fixing unit **30***a* shown in FIGS. **9**A and **9**B and includes the separating units **80**, which are the separating device, and the insertion members **710**. The control section **101***a*, through the control of the fixing section **102***a*, causes the insertion members **710** to be inserted into the spaces when the rotation of the rotatable members **40** is completed and causes the insertion members **710** to be retracted therefrom when the rotation of the rotatable members **40** is started. By inserting the insertion members **710**, the rotatable members **40** will touch only the insertion members **710**, not the medium P1, even if the medium P1 becomes wavy and moves in the top-bottom direction A7. Accordingly, even if a portion of the medium P1 softens, the portion does not adhere to the rotatable members **40** but it adheres to the insertion members **710**. The operation of inserting/retracting the insertion members **710** into/from the spaces by the control section **101***a* is the above-described suppressing operation (operation for preventing a portion of the medium P1 from softening, peeling off, and adhering to the rotatable members **40**). The image forming system **1***a* performs the adhesion prevention processing in this exemplary embodiment, using the above-described configuration.

[3-3] Operation

FIG. **11** is a flowchart showing an exemplary operation of the image forming system **1** according to this exemplary embodiment in the adhesion prevention processing. FIG. **11** shows the operation performed when the rotation of the rotatable members **40** is stopped. First, the image forming system **1***a* performs the operation of step **S11** (image forming processing) shown in FIG. **5**. Next, the image forming system **1***a* determines if the transportation of the medium has been completed (step **S41**). When it is determined that the transportation of the medium has not yet been completed (NO), the image forming system **1***a* repeatedly performs the operation of step **S41**. When it is determined that the transportation of the medium has been completed (YES), the image forming system **1***a* moves the rotatable members **40** to create spaces, such as the spaces M1 and M2 as shown in FIG. **9**B, between the rotatable members **40** and the medium P1 (step **S42**). Next, the image forming system **1***a* inserts the insertion members **710** into the spaces (step **S43**). As a result, the insertion members **710** and the rotatable members **40** are in the state shown in FIG. **9**B.

FIG. **12** is a flowchart showing another exemplary operation of the image forming system **1** according to this exemplary embodiment in the adhesion prevention processing. FIG. **12** shows the operation to be performed when the rotation of the rotatable members **40** is started after the operation of FIG. **11** is performed. That is, when the operation shown in FIG. **12** is to be started, the insertion members **710** are inserted into the spaces M1 and M2 between the rotatable members **40** and the medium P1. In this state, first, the image forming system **1***a* performs the operation of step **S31** (receive image data) shown in FIG. **7**. Next, the image forming system **1***a* retracts the insertion members **710** from the spaces M1 and M2 (step **S51**). Then, the image forming system **1***a* returns the moved rotatable members **40** to the original position (step **S52**) and performs the operation of step **S36** (image forming processing).

[3-4] Advantage of Third Exemplary Embodiment

As has been described above, in this exemplary embodiment, the medium P1 stops without touching the rotatable members **40**. Even if the medium P1 softens at this time, the softened medium P1 adheres to the insertion members **710**. Hence, in this exemplary embodiment, the softened medium does not adhere to the rotatable members **40**. Furthermore, even if a force is applied to the insertion members **710**, bringing the insertion members **710** into contact with the rotatable members **40**, because the heat of the rotatable members **40** is used to heat the insertion members **710**, the amount of heat conducting to the medium P1 is smaller than in a case where the rotatable members **40** are in contact with the medium P1. Moreover, in this exemplary embodiment, as described above, because the insertion members **710** have lower thermal conductivity, higher thermal resistance, or larger specific heat than the rotatable members **40**, the heat of the rotatable members **40** is less likely to conduct to the medium P1, and thus, the medium P1 is less likely to soften than in a case where such insertion members **710** are not used.

[4] Modifications

The above-described exemplary embodiments are merely examples of the present invention and may be modified as described below. Furthermore, the above-described exemplary embodiments and the modifications shown below may be combined for implementation if necessary.

[4-1] Change First and Second Temperature

In the first and second exemplary embodiments, the control section **101** may change the first and second temperatures.

FIG. **13** is a diagram showing an example of a fixing unit according to this modification. In this example, a fixing unit **30***b* having adhesion detecting sensors **91** and **92** (hereinbelow, collectively referred to as "adhesion detecting sensors **90**" where distinction is not needed) in addition to the components shown in FIG. **3** is shown. The adhesion detecting sensors **90** are sensors for detecting if a portion of the softened medium P1 adheres to the surfaces of the rotatable members **40**. The adhesion detecting sensors **90** are, for example, image sensors and, in such as case, detect the intensity of color in areas (hereinbelow, "detection areas") from one end to the other end, in the width direction, of the surfaces of the rotatable members **40**. The adhesion detecting sensors **90** supply the control unit **5** with data indicating that the intensity is constant when a portion of the softened medium P1 does not adhere to the detection area, and data indicating that the intensity is varied when a portion of the softened medium P1 adheres to the detection area.

In this exemplary embodiment, the control section **101** changes the first and second temperatures depending on the degree to which the medium P1 adheres to the rotatable members **40** (hereinbelow, "degree of adhesion"). The control section **101** determines the degree of adhesion by the proportion of the area of a portion having varied intensity in the detection area (hereinbelow, "adhesion rate"). The control section **101** stores correlation data showing the correlation between the adhesion rate and the first and second temperatures.

FIGS. **14**A and **14**B show examples of the correlation data. FIGS. **14**A and **14**B show graphs in which the vertical axis indicates the adhesion rate (in percent (%)) and the horizontal axis indicates the first and second temperatures (in degrees (° C.)). In the graphs, Tx denotes the softening temperature of the medium P1, T1 denotes the initial first temperature, T2 denotes the initial second temperature, Ty denotes the lower-limit temperature, and Tz denotes the fixing temperature. The initial first temperature and the initial second temperature are the first temperature and the second temperature when the adhesion rate is 0%. At the initial stage before an image is formed on the medium P1, the first and second temperatures are set to these values. The lower-limit temperature is the lowest first temperature and is set to a temperature higher than or equal to the temperature reached when the heated surfaces of the rotatable members **40** cool. Otherwise (if lower than this), the surface temperature of the rotatable members **40** will not reach the first temperature, and the rotation will not be stopped.

As shown in FIG. **14**A, at an adhesion rate of 0%, the first temperature is the initial first temperature T1, which is lower than the softening temperature Tx, and, as the adhesion rate increases, the first temperature decreases toward the lower-limit temperature Ty. As shown in FIG. **14**B, at an adhesion rate of 0%, the second temperature is the initial second temperature T2, which is higher than or equal to the softening temperature Tx, and, as the adhesion rate increases, the second temperature increases toward the fixing temperature Tz. For example, the control section **101** detects the adhesion rate and changes the first temperature to a value corresponding to the detected adhesion rate before starting the rotation of the rotatable members **40** that has been stopped and before a portion thereof that has been in contact with the medium P1 will come into contact with the medium P1 again. Furthermore, for example, the control section **101** detects the adhesion rate after starting the rotation of the rotatable members **40** and immediately before a formed toner image arrives at the nip area N1, and changes the second temperature to a value corresponding to the detected adhesion rate.

In the examples of FIGS. **14**A and **14**B, the first and second temperatures are each shown as a quadratic curve that converges on the lower-limit temperature or the fixing temperature. However, it is also possible that the first and second temperatures are changed linearly to the lower-limit temperature and the fixing temperature, respectively, from where the temperatures are not changed. Furthermore, the degree of adhesion does not necessarily have to be expressed by adhesion rates, but by levels determined by, for example, ranges of the adhesion rate (e.g., an adhesion rate of less than 5% is level 1, an adhesion rate of 5% or more to less than 10% is level 2, and an adhesion rate of 10% or more is level 3). That is, it is only needed that the degree of adhesion indicates the degree to which the medium P1 adheres to the rotatable members **40**.

In the first exemplary embodiment, even when the surface temperature when the rotatable members **40** are stopped is lower than or equal to the first temperature (i.e., lower than the softening temperature), the surfaces of the medium P1 may soften and a portion thereof may adhere to the rotatable members **40** due to the temperature of the medium P1 itself and due to the quality of the coating material (i.e., softenable layers P10). Furthermore, temperature higher than or equal to the softening temperature may be used as the first temperature for such reasons that the softening temperature of some media is unknown and that the type of the media is frequently changed. In this modification, in such a situation, by changing the first temperature depending on the detected adhesion rate as described above, the surface temperature will be a lower first temperature when the rotatable members **40** are stopped next time. With this configuration, the surfaces of the medium P1 are less likely to soften and, hence, a portion thereof is less likely to adhere to the rotatable members **40** than in a case where the first temperature is not changed.

Furthermore, in the second exemplary embodiment, even if the surface temperature when the rotation of the rotatable members **40** is started is higher than or equal to the second temperature (i.e., higher than or equal to the softening temperature), the adherent (a portion of the medium P1 adhered to the rotatable members **40**) may not sufficiently soften and, thus, may not be detached from the rotatable members **40**. In this modification, in such a case, the second temperature is changed depending on the detected adhesion rate, as described above. With this configuration, the adherent is more likely to soften and is more easily detached from the rotatable member than in a case where the second temperature is not changed.

[4-2] Start Image Forming Depending on Adhesion Rate

The control section **101** may determine the timing of starting the toner image depending on the above-described degree of adhesion.

FIG. **15** is a diagram showing an exemplary functional configuration of the image forming system according to this modification. In this example, an image forming system **1***b* including a control section **101***b*, the fixing section **102**, the transport section **103**, and a forming section **104** is shown. The forming section **104** is an example of a device that forms a toner image on a medium transported by the transport section **103**. The control section **101***b* controls the forming section **104** to start formation of a toner image on a medium when the degree of adhesion satisfies a predetermined condition.

An example of the predetermined condition is a condition that is satisfied when the adhesion rate, if it is used as the degree of adhesion, is below the threshold (for example, 3%). In this case, when the detected adhesion rate is higher than or equal to the threshold, the control section **101** heats the rotatable members **40** and transports the medium P1 without starting the formation of a toner image to detach the adherent, and, when the detected adhesion rate is lower than the threshold, the control section **101** starts the formation of a toner image. According to this modification, when an allowable degree of adhesion is determined (for example, when the adhesion of an adherent to a portion of a medium on which a toner image is to be formed is allowed if the adhesion rate is less than 3%), the degree of adhesion is used as the threshold. By doing so, the formation of a toner image is started early compared with a case where the above-described control of the forming section **104** is not performed.

[4-3] Start Image Formation According to Time Elapsed

The control section **101** may determine the timing of starting the formation of a toner image according to criteria other than the degree of adhesion. More specifically, the control section **101** may determine the timing according to the time elapsed since the start of the rotation of the rotatable members **40** (for example, the formation of a toner image is started when 10 seconds has elapsed). Alternatively, the control section **101** may determine the timing according to the length of the medium transported (for example, the formation of a toner image is started when the medium has been transported for three meters).

[4-4] First Temperature Higher than or Equal to Softening Temperature

Although a case where the first temperature is lower than the softening temperature has been described in the first exemplary embodiment, the first temperature may be higher than or equal to the softening temperature. Although the first temperature is desirably lower than the softening temperature, the first temperature could be higher than or equal to the softening temperature for such reasons that, in the case of the medium P1, the softening temperature indicated as product information is different from the actual softening temperature due to the quality of the coating material (i.e., softenable layers P10) or the like, that the softening temperature of some media is unknown, and that there is little time to change the first temperature due to frequent changes in type of the medium. Even in such a case, by determining the first temperature, softening of the medium after stopping the transportation of the medium is less likely to occur than in a case where the rotation of the rotatable members **40** is stopped at a temperature higher than the first temperature.

[4-5] Second Temperature Lower than Softening Temperature

Although a case where the second temperature is higher than or equal to the softening temperature has been described in the second exemplary embodiment, the second temperature may be lower than the softening temperature. Although the second temperature is desirably higher than or equal to the softening temperature, the second temperature could become lower than the softening temperature for the same reasons as the first temperature. Even in such a case, by determining the second temperature, the surface temperature of the rotatable members **40** increases quickly and the adherent becomes an easily separable state compared with a case where the rotation of the rotatable members **40** is started at a temperature lower than the second temperature. As a result, if the timing of starting the formation of a toner image is the same, more adherent are separated than the above-described case. In this modification too, a temperature lower than the fixing temperature is used as the second temperature. The reason for this is that, because the rotatable members **40** will not be heated above the fixing temperature, a medium that softens only at a temperature higher than that will not adhere to the rotatable members **40**.

[4-6] Medium

Although cases where the medium P1 having the coating material on each surface (i.e., the medium P1 having the softenable layers P10 on both of the front and rear surfaces thereof) is used have been described in the above-described exemplary embodiments, a medium having the coating material on either one of the front and rear surfaces may be used. In this case too, the surface with the coating material may soften and adhere to the rotatable members **40**. Furthermore, the medium is not limited to those having a softenable layer as a coating layer. For example, the medium may be a sheet member that is made of, for example, polypropylene that softens at a temperature lower than or equal to the fixing temperature. This medium also has a softenable layer on the surface thereof, so, the softenable layer may soften and adhere to the rotatable members **40**. When the medium having a softenable layer is used for forming an image, it is desirable that the control section **101** perform control using the first and second temperatures determined according to the softening temperature of the softenable layer, as in the first and second exemplary embodiments.

[4-7] Transport Passed Medium in Opposite Direction

In the first exemplary embodiment, the control section **101** may transport the medium that has been transported since the completion of the fixing until the stopping of the rotation of the rotatable members **40** in the direction opposite to the transport direction, at the next start of the rotation of the rotatable members **40**. This portion of the medium does not have a toner image fixed thereto. In other words, an image is not formed thereon. Hereinbelow, such a medium will be referred to as an "unformed medium". If a next image is to be formed without taking any measure, the unformed medium is wasted. However, in this modification, because the unformed medium is transported in the opposite direction and then an image is formed, the medium is not wasted. Note that it is desirable that the transportation of the unformed medium in the opposite direction by the control section **101** be performed when the medium does not soften or adheres to the rotatable members **40** owing to the control explained in the first exemplary embodiment.

[4-8] Control Only Fixing Device

Although the control section **101** controls the fixing section **102** and the transport section **103** in the above-described exemplary embodiments, the control section **101** may control only the fixing section **102**. In such a configuration, the operation of reducing the transport speed and the operation of reversing the transport direction, which have been described in the first and second exemplary embodiments, are not performed. However, even in such a configuration, a portion of the medium softened by the heat of the rotatable members heated in the fixing still becomes less likely to adhere to the medium than in a case where the control of the fixing section is not performed.

[4-9] Fixing Unit

The fixing unit is not limited to those described in the above-described exemplary embodiments. For example, although the rotatable members provided in the fixing unit were rollers according to the above-described exemplary embodiments, they may alternatively be endless belts. That is, the rotatable members may be anything as long as they are capable of applying heat and pressure to the medium while being heated. Furthermore, the heaters of the fixing unit employ halogen lamps to heat the rotatable members **40** in the above description, induction heating (IH) heaters may also be used. That is, the heaters may be anything as long as they are capable of heating the rotatable members.

[4-10] Insertion Member

The insertion members are not limited to those described in the third exemplary embodiment.

FIGS. **16**A and **16**B are diagrams showing an example of an insertion member according to the modification. FIGS. **16**A and **16**B show the end faces of the fixing unit and medium P1, as viewed in the direction indicated by the allows IX-IX in FIG. **8**, similarly to FIGS. **9**A and **9**B, and show only one of the rotatable members **40**. FIG. **16**A shows a fixing unit **30***c* that includes an insertion member **710***c* having a round end face. Like this one, the insertion member do not necessarily has to be plate-shaped as shown in FIGS. **8** and **9**, as long as it separates the rotatable member **40** and the medium P1.

Furthermore, FIG. **16**B shows a fixing unit **30***d* that includes an insertion member **710***d* having a first member **711***d* and a second member **712***d*, which are both plate-shaped. The first member **711***d* is made of, for example, metal, and the second member **712***d* is made of, for example, resin. Thus, the first member **711***d* has higher thermal conductivity than the second member **712***d*. Furthermore, several protrusions ("protruding portions **713***d*") are formed on the surface of the first member **711***d*, at both ends in the transport direction A3. With this configuration, a portion of the heat conducting to the insertion member **710***d* due to the heat radiation from the rotatable member **40** or a portion of the heat conducting to the insertion member **710***d* when the protruding portions **713***d* are brought into contact with the rotatable member **40** upon application of a force diffuses in the first member **711***d* and is radiated to the air from the protruding portions **713***d*. Thus, the amount of heat conducting from the rotatable member **40** to the medium P1 decreases, making the medium P1 less likely to soften than in a case where the insertion member does not have the first member **711***d*. Note that the protruding portions of the first member are optional. The insertion member may have only the first member. Even in such a configuration, the heat conducting from the rotatable member **40** diffuses in the first member and conducts to the medium P1 in a diffused manner, without being focused on a certain portion thereof. Accordingly, the medium P1 is less likely to soften than in a case where the insertion member does not have the first member.

[4-11] Image Forming Apparatus

Although the image forming apparatus according to the above-described exemplary embodiments forms color images using the photoconductor drums and developing devices arranged along the intermediate transfer belt, the image forming apparatus may be of any configuration as long as it fixes a toner image onto a medium. For example, the image forming apparatus may have a rotary developing device having developing devices provided along the circumferential direction of a rotary member, or may be of a direct-transfer type in which a toner image is directly transferred from a photoconductor drum to a recording medium.

[4-12] Category of Invention

The present invention may be understood as, not only an image forming apparatus and an image forming system having the image forming apparatus, but also a fixing device having a fixing section and a control section.

FIGS. **17**A and **17**B are diagrams showing exemplary hardware configuration and functional configuration of the fixing device. FIG. **17**A shows an image forming apparatus **3***e* including a fixing device **300**. The fixing device **300** includes a fixing unit **30***e* and a control unit **7**. The fixing unit **30***e* has the same configuration as the above-described fixing unit. The control unit **7** has the same configuration as the control unit **5**. The fixing device **300** having such a hardware configuration achieves the functions, i.e., a control section **101***e* and a fixing section **102***e*, as shown in FIG. **17**B. These sections achieve the same functions as those achieved by the above-described sections having the same name.

Furthermore, the present invention may also be understood as a processing method for achieving processing performed by an image forming system. The processing as used herein is, for example, the adhesion prevention processing shown in FIG. **5** etc. Furthermore, the present invention may also be understood as a program for making a computer, such as an image forming system, function as the sections shown in FIG. **4** etc. This program may be provided in the form of a recording medium, such as an optical disc, that stores the program or by allowing a computer to download through a network such as the Internet and install to be used.

The foregoing description of the exemplary embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A fixing device comprising:

a fixing section that includes rotatable members arranged to form a nip area through which a strip-shaped medium passes, and heaters that heat the rotatable members; and

a control section,

wherein the fixing section applies heat and pressure to a toner image that is formed on the medium and passes through the nip area via the rotatable members heated by the heaters to fix the toner image onto the medium,

wherein the medium has softenable layers, and

wherein the control section performs such control that the rotation of the rotatable members is stopped when the temperature of contact portions of the rotatable members that are in contact with the medium is lower than or equal to a first temperature that is lower than a temperature at which a portion of the medium softens, the temperature at which the portion of the medium softens being a temperature at which at least one of the softenable layers softens.

2. The fixing device according to claim **1**,

wherein the medium has the softenable layers on a surface thereof, and

wherein the first temperature is a temperature that is lower than a temperature at which the at least one softenable layer of the medium softens.

3. The fixing device according to claim **1**, wherein, after the toner image is fixed onto the medium, the control section controls a transport device, which transports the medium, to reduce a transport speed at which the medium is transported or repeatedly reverse a transport direction in which the medium is transported.

4. The fixing device according to claim **1**, wherein the control section changes the first temperature depending on the degree to which the medium adheres to the rotatable members.

5. A fixing device comprising:

a fixing section that includes rotatable members arranged to form a nip area through which a strip-shaped medium passes, and heaters that heat the rotatable members; and

a control section,

wherein the fixing section applies heat and pressure to a toner image that is formed on the medium and passes through the nip area via the rotatable members heated by the heaters to fix the toner image onto the medium,

wherein the medium has softenable layers, and

wherein the control section performs such control that the rotation of the rotatable members is started when the temperature of contact portions of the rotatable members that are in contact with the medium is higher than or equal to a second temperature that is higher than or equal to a softening temperature at which a portion of the medium softens, the softening temperature being a temperature at which at least one of the softenable layers softens.

6. The fixing device according to claim **5**,

wherein the medium has the softenable layers on a surface thereof, and

wherein the second temperature is higher than or equal to a temperature at which the at least one softenable layer of the medium softens.

7. The fixing device according to claim **5**, wherein, after the temperature of the contact portions has reached or exceeded the second temperature, the control section controls the transport device, which transports the medium, to gradually increase the transport speed at which the medium is transported.

8. The fixing device according to claim **5**, wherein, after the temperature of the contact portions has reached or exceeded the second temperature, the control section controls the transport device to repeatedly reverse the transport direction in which the medium is transported.

9. The fixing device according to claim **5**, wherein the control section changes the second temperature depending on the degree to which the medium adheres to the rotatable members.

10. The fixing device according to claim **1**, wherein the fixing section does not have a separating device that separates the rotatable members and the medium.

11. The fixing device according to claim **1**,

wherein the fixing section includes a separating device that separates the rotatable members and the medium, and an insertion member that is to be inserted into or refracted from a space between the rotatable members and the medium, which space is created by the separating device, and

wherein the control section inserts the insertion member into the space when the rotation of the rotatable members is completed, and retracts the insertion member from the space when the rotation of the rotatable members is started.

12. The fixing device according to claim **11**, wherein the insertion member has lower thermal conductivity, higher thermal resistance, or greater specific heat than the rotatable members.

13. A fixing device comprising:

a fixing section that includes rotatable members arranged to form a nip area through which a strip-shaped medium passes, and heaters that heat the rotatable members; and

a control section,

wherein the fixing section applies heat and pressure to a toner image that is formed on the medium and passes through the nip area to fix the toner image to the medium via the rotatable members heated by the heaters,

wherein the medium has softenable layers, and

wherein the control section controls the fixing section to perform an operation for preventing one or more of the softenable layers of the medium heated by the heat of the rotatable members that have stopped upon the completion of the fixing from softening, peeling off, and adhering to the rotatable members.

14. An image forming apparatus comprising:

the fixing device according to claim **1**;

a transport device that transports a strip-shaped medium; and

a forming device that forms a toner image on the medium transported by the transport device.

15. The fixing device according to claim **6**, wherein, after the temperature of the contact portions has reached or exceeded the second temperature, the control section controls the transport device, which transports the medium, to gradually increase the transport speed at which the medium is transported.

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